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**Maternal posttraumatic stress disorder during the perinatal period and child outcomes:
a systematic review**

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Abstract

Background

Approximately 3.3% of women in pregnancy have posttraumatic stress disorder (PTSD) and 4% of women postpartum PTSD. The impact of maternal PTSD during the perinatal period (from conception until one year postpartum) on child outcomes has not been systematically examined.

Method

A systematic review was conducted to synthesize and critically evaluate quantitative research investigating the association between perinatal PTSD and child outcomes. Databases EMBASE, BNI, Medline, PsycInfo and CINAHL were searched using specific inclusion and exclusion criteria.

Results

26 papers reporting 21 studies were identified that examined associations between perinatal PTSD and postpartum birth outcomes, child development, and mother-infant relationship. Studies reviewed were heterogeneous, with poor-to-medium scores of methodological quality. Results showed that maternal postpartum PTSD is associated with low birth weight and lower rates of breastfeeding. Evidence for an association between maternal PTSD and preterm birth, fetal growth, head circumference, mother-infant interaction, the mother-infant relationship or child development is contradictory. Associations between maternal PTSD and infant salivary cortisol levels, and eating/sleeping difficulties are based on single studies, so require replication.

Limitations

Methodological weaknesses of the studies included insufficient sample size, use of invalidated measures, and limited external validity.

Conclusion

Findings suggest that perinatal PTSD is linked with some negative child outcomes. Early screening for PTSD during the perinatal period may be advisable and onward referral for effective treatment, if appropriate. Future research using larger sample sizes, validated and reliable clinical interviews to assess PTSD, and validated measures to assess a range of child outcomes, is needed.

Keywords: posttraumatic stress disorder; postnatal; pregnancy; birth outcomes; child development; mother-infant relationship

1. Introduction

Childbirth is a complex, sometimes traumatic, event that can pose a threat to the life of the mother and/or her child (Olde, van der Hart, Kleber, & van Son, 2006), leading to the development of posttraumatic stress disorder (PTSD). Posttraumatic stress disorder consists of four sets of symptom clusters (intrusion or re-experiencing; avoidance; negative alterations in mood or cognitions, and increased arousal), which must have lasted for at least one month, and significantly impair their functioning (American Psychiatric Association, 2013). Individuals must have been exposed to actual or threatened death, serious injury, or sexual violence. This exposure can be direct, witnessed, indirect (e.g., by hearing of a relative or close friend who has experienced the event), or repeated or extreme indirect exposure (American Psychiatric Association, 2013).

Women can have PTSD in the perinatal period, defined as extending from when pregnancy begins, up to one year following childbirth (McKenzie-McHarg, et al., 2015). A recent systematic review and meta-analysis of PTSD reported prevalence rates of 3.3% during pregnancy and a further 4% of postpartum PTSD, mostly in relation to traumatic events during birth (Yildiz, Ayers, & Phillips, 2017). Prevalence is greater in high-risk samples, such as women who have severe complications in pregnancy or during childbirth, with rates of 15-18% (Grekin & O'Hara, 2014; Horsch, Brooks, & Fletcher, 2013; Yildiz, et al., 2017), after premature birth (e.g., Horsch, Tolsa, et al. (2015)), after emergency cesarean section (e.g., Horsch, et al. (2017)) or after stillbirth (e.g., Horsch, Jacobs, and McKenzie-McHarg (2015)). However, it is likely that most studies underestimate the total prevalence of PTSD in the postpartum period by only examining PTSD related to traumatic childbirth experiences (Yildiz, et al., 2017).

Posttraumatic stress disorder in pregnant women has been studied to an even lesser extent than PTSD in the postpartum period. On average, the prevalence of PTSD during

pregnancy is 3.3% in community samples and 18% in high risk samples (Yildiz, et al., 2017), with higher rates in high risk samples. For example, one study found that 69% of pregnant women in a convenience sample had experienced a violent traumatic event (mostly interpersonal violence); 58% of this sample met diagnostic criteria for PTSD (Harris-Britt, Martin, Li, Casanueva, & Kupper, 2004).

Although PTSD occurring at any time is of concern, experiencing such symptoms during pregnancy can pose additional difficulties, as it may increase the risk for pregnancy complications and negative birth outcomes. For example, PTSD during pregnancy has been linked to neuroendocrine alterations, such as the dysregulation of cortisol, vasopressin, and oxytocin, which may directly predispose women to birth complications (Friedman & McEwen, 2003; Marshall & Garakani, 2002). This may also predispose infants to a biological vulnerability to PTSD (Yehuda, et al., 2005). Furthermore, PTSD is associated with high rates of psychiatric comorbidities (Keane & Kaloupek, 1997), including anxiety and depression, which may also increase risks for preterm delivery, low birth weight, and reduced fetal growth (Morland, et al., 2007).

Various factors make women susceptible to developing PTSD following childbirth. A recent meta-analysis of risk factors found that negative subjective birth experiences, having an operative birth, lack of support, and dissociation were associated with postpartum PTSD and depression (Ayers, Bond, Bertullies, & Wijma, 2016). Evidence suggests that other factors might also be important, such as the baby's gender, level of social support following childbirth, history of mental health problems, and stressful life events (Creedy, Shochet, & Horsfall, 2000; Ford & Ayers, 2011; Grekin & O'Hara, 2014; Iles, Slade, & Spiby, 2011; Soderquist, Wijma, & Wijma, 2006; Tamaki, Murata, & Okano, 1997). In addition, cognitive behavioral factors, such as the nature of the trauma memory, negative cognitive appraisals, and safety behaviors may also contribute to the development of PTSD following childbirth

(Ford, Ayers, & Bradley, 2010; King, McKenzie-McHarg, & Horsch, 2017; Vossbeck-Elsebusch, Freisfeld, & Ehring, 2014).

A few studies have highlighted the impact that postpartum PTSD may have on child development. Child development can be understood as a dynamic and ongoing process that is influenced by a complex network of biological, psychological, and social factors (Stuadinger & Lindenberger, 2003). The lifespan perspective assumes that development is lifelong, multi-dimensional and multi-directional, highly plastic, and affected by multiple interacting forces (Stuadinger & Lindenberger, 2003). Events occurring during each major period of child development, from prenatal to adolescence, can have powerful effects on future change. These changes can occur across multiple domains (including physical, cognitive, emotional, and social), and the challenges and adjustments to this development can be affected by a complex combination of any multitude of these factors (Berk, 2007). As a result, inequalities in health, cognitive development, and socio-emotional functioning can emerge in early life, highlighting the importance of early intervention in promoting optimal well-being for the child and their family system (Doyle, Harmon, Heckman, & Tremblay, 2009).

Even from the earliest stages of life, environmental factors, such as poor maternal nutrition and substance use, can have a profound influence on fetal and child development, including cognitive and behavioral impairment, as well as adverse fetal outcomes (Langley-Evans, 2006; Fifer & Moon, 2007). In turn, adverse fetal outcomes, such as low birth weight, are correlated to deficits in academic achievement, attentional problems, and internalizing behavioral problems (Aarnoudse-Moens, Weisglas-Kuperus, van Goudoever, & Oosterlaan, 2009). Additionally, not being breastfed is associated with an increased incidence of infectious morbidity in infants, as well as elevated risks of childhood obesity, and sudden infant death syndrome (Stuebe, 2009).

Attachment theory highlights the importance of relational patterns within the first two years of life, as experiencing a sensitive and responsive interaction with a caregiver is considered essential for the development of an infant's secure attachment (Bowlby, 1973). Insecure attachment had been found to be a risk factor for a range of later social and cognitive difficulties; parental mental health problems can directly contribute to this, as they are often linked with disrupted patterns of interaction with their child (Madigan, Moran, & Pederson, 2006). However, research has also suggested that early attachment does not necessarily predict attachment later in development (Groh, et al., 2014).

Mounting evidence suggests that postpartum PTSD may impact on the mother-infant relationship, as well as infant behavior and cognitive development (Ayers, Eagle, & Waring, 2006; Creedy, et al., 2000; Paykel, 2003; Shaw, et al., 2009; Soderquist, et al., 2006). For example, a large longitudinal study of 1472 women found maternal postpartum PTSD symptoms eight weeks after birth were associated with poor social-emotional development at two years, particularly in boys and children with an early difficult temperament (Garthus-Niegel, Ayers, Martini, von Soest, & Eberhard-Gran, 2017).

Whilst a reasonable amount of research has been conducted investigating the role of risk factors in the development of PTSD in women during both the antenatal and postpartum period, there is less research examining the impact of PTSD during the perinatal period on child outcomes. Nevertheless, PTSD may be an important underlying mechanism for understanding perinatal health, birth complications, and birth outcomes, both through the associated negative behaviors that women may display, and also through a more direct association with neuroendocrine pathways. Morland, et al. (2007) suggest that PTSD can affect maternal and fetal health directly (e.g., through immunologic and endocrine factors), or via maladaptive responses (e.g., anxiety, depression, somatization), which can also contribute

to negative health behaviors (such as smoking, substance abuse, or overeating to soothe emotional discomfort, possibly leading to obesity).

This review aimed to systematically review and summarize research investigating the association between maternal PTSD during the perinatal period (beginning of pregnancy until first year postpartum) and child outcomes. Child outcomes are grouped into postpartum birth outcomes, child development, and mother-infant relationship.

2. Method

2.1. Search strategy

Studies were identified by systematically searching the following databases: EMBASE, BNI, Medline, PsycInfo and CINAHL. Search terms were grouped under three main headings: perinatal-related; posttraumatic stress disorder-related; and child outcome-related. These search terms were combined (see Appendix A for complete search strategy). Searches were restricted to peer-reviewed articles published in English between 1980 and March 2016.

Inclusion criteria were: report of primary research; samples of women, or a separate report of women's results; data was collected during the perinatal period (from pregnancy to one year postpartum); report of PTSD symptoms and/or diagnosis during the perinatal period, which was measured using a questionnaire, interview, or clinical code. Papers had to also include child outcomes and examine the association between these and maternal PTSD. Studies were excluded if women's findings were not reported separately, or if there was no assessment of perinatal PTSD symptoms. Furthermore, if co-morbid conditions were described, PTSD needed to be reported separately from other comorbid conditions.

The initial search identified 357 articles. Seventy-one duplicates were removed, and the remaining articles were screened for suitability in accordance with inclusion criteria.

Secondary searches involved scanning publication reference lists, accessing online citations, and manual searches of relevant journals. Experts in the field and primary authors were contacted for access to further publications. An additional 18 articles were identified through secondary searches, totaling 304 articles. This resulted in 50 articles undergoing full-text review, and 26 original articles meeting all the above criteria (see Figure 1).

2.2. Procedure

The procedure for this review followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses protocols (Shamseer, et al., 2015). Eligible papers were evaluated using a standardized tool (see supplementary materials) developed for this review to extract data from each of the included articles. The key characteristics of the quantitative research that were considered included: aims and hypotheses, recruitment of participants, inclusion and exclusion criteria, sample size calculation, number of groups, PTSD measure, child outcome measure. The data extracted were then reviewed using a descriptive approach to summarize the key findings. The methodological quality of each study was assessed using a checklist based on Downs and Black's (1998) feasibility checklist, which assessed the reporting, internal and external validity, and power of the studies.

Child outcomes were grouped into one or more of the following categories: postnatal birth outcomes (i.e., fetal growth, low birth weight, gestational duration, preterm birth, head circumference, breastfeeding), child development (i.e., cognitive development, sleeping and eating difficulties, salivary cortisol), or mother-infant relationship (i.e., maternal interactional behavior, infant interactional behavior, parent-infant bond).

3. Results

3.1. Study characteristics

Twenty-six papers reporting 21 studies were included in the review. The majority reported on mother-infant relationship or interaction ($n=11$) or birth outcomes ($n=11$). There were fewer studies looking at cognitive development ($n=4$). The total number of women included in this review was 9942 across 21 research studies¹. The studies recruited participants from a range of developed countries, including the United Kingdom (UK) ($n=5$), USA ($n=11$), Canada ($n=1$), Switzerland ($n=1$), Italy ($n=1$), Israel ($n=1$), and Brazil ($n=1$). Studies varied in methodological approach, including the use of cross-sectional design ($n=1$), prospective epidemiological design ($n=1$), longitudinal epidemiological design ($n=1$), prospective study design ($n=6$), longitudinal study design ($n=9$), and survey design ($n=3$). Methodological quality was poor to medium with scores ranging from 8 to 16 on a 30-point scale, and over 19% of papers scoring over 15.

A total of 9392 mothers were sampled in 16 papers. 589 families or couples were sampled in the remaining 10 papers, of which 550 mothers participated in the study. Across the 26 papers, 1262 women were classified as having partial or high PTSD symptomatology. However, four studies did not report this figure (Parfitt, Ayers, Pike, Jessop, & Ford, 2014; Pierrehumbert, Nicole, Muller-Nix, Forcada-Guex, & Ansermet, 2003; Seng, et al., 2013; Yehuda, et al., 2005), which means that conclusions should be drawn cautiously.

Participant ages ranged from 11 to 52, although this should be interpreted with caution as one study did not report maternal and paternal ages separately (Parfitt, Pike, & Ayers, 2014), and four studies did not report an upper range limit (Lipkind, Curry, Huynh, Thorpe, & Matte, 2010; Xiong, et al., 2008; Yehuda, et al., 2005; Yonkers, et al., 2014). Furthermore, five studies did not specify the age of their sample (Beck, Gable, Sakala, & Declercq, 2011; Engel, Berkowitz, Wolff, & Yehuda, 2005; Forcada-Guex, Borghini,

¹ Several papers used participants from the same study, including: (a) Pierrehumbert et al. (2003), Muller-Nix et al. (2004), and Forcada-Guex et al. (2011); (b) Engel et al. (2005) and Yehuda et al. (2005); (c) Parfitt et al. (2013), Parfitt et al. (2014a) and Parfitt et al. (2014b).

Pierrehumbert, Ansermet, & Muller-Nix, 2011; Parfitt, et al., 2014; Seng, Low, Sperlich, Ronis, & Liberzon, 2011). Being able to draw across a broad range of ages makes the findings of these studies more generalizable.

The majority of participants identified as White or Caucasian (52%, $n=5237$). The remaining participants were Non-White/Other (14%, $n=1553$), Black or African American (10%, $n=1026$), Hispanic (7%; $n=657$), Middle Eastern (2%, $n=190$), or identified as Asian (1%, $n=84$) or Pacific Islander (1%, $n=130$). The ethnicity of 13% of participants was unknown or not reported (Davies, Slade, Wright, & Stewart, 2008; Ferri, et al., 2007; Ionio & Di Blasio, 2014; Pierrehumbert, et al., 2003; Yehuda, et al., 2005). Although the ethnic diversity of participants was reasonably high across studies, inclusion criteria of several studies required participants to speak English ($n=11$), which likely reduced the opportunities of women from ethnically diverse backgrounds to participate. The majority of samples were non-random and convenience in nature. Participants were recruited from hospital or obstetric clinics ($n=12$), prenatal clinics ($n=5$), an established registry of self-referred women exposed to a terrorist attack ($n=2$), a database of insurance claims ($n=1$), and online ($n=1$).

Mothers had experienced a range of potential traumas, although these were not specified in the majority of studies ($n=16$). Of those who did specify the trauma, two studies sampled women who had been exposed to a terrorist attack (9/11 World Trade Centre attacks: Lipkind, et al. (2010); Yehuda, et al. (2005), one study sampled women who had been exposed to a natural disaster (Hurricane Katrina: Xiong, et al. (2008)), and two studies sampled women who had experienced their infant in a Neonatal Intensive Care Unit (NICU) (Feeley, et al., 2011; Pierrehumbert, et al., 2003).

The majority of studies described their inclusion or exclusion criteria ($n=14$), although this varied across studies. Seven studies did not clearly define their inclusion criteria (Ferri, et al., 2007; Ionio & Di Blasio, 2014; Lipkind, et al., 2010; McDonald, Slade, Spiby,

& Iles, 2011; Morland, et al., 2007; Seng, et al., 2001; Yehuda, et al., 2005). Not having this information makes it difficult to know whether samples are representative of the population from which they are recruited, and increases risk of bias. It also makes it difficult for researchers to replicate the study to measure external validity. Some studies specified inclusion criteria in relation to infant outcomes. For example, two studies used NICUs for mothers of preterm infants (Feeley, et al., 2011; Pierrehumbert, et al., 2003), providing opportunities to research a population, which is at an increased risk of developing perinatal PTSD. Four studies specifically recruited women expecting their first baby or after their first birth (Halperin, Sarid, & Cwikel, 2015; Parfitt, Pike, & Ayers, 2013; Seng, et al., 2011; Seng, et al., 2013), which limits the generalizability of these findings only to first-time mothers, but may reduce confounding variables associated with previous childbirth and motherhood.

3.2. Birth outcomes

Eleven papers reported on the association between maternal perinatal PTSD and post-natal birth outcomes, including fetal growth, gestational duration and preterm birth, head circumference, and breastfeeding (Table 1).

3.2.1. Fetal growth

Evidence for a relationship between antenatal PTSD and fetal growth was inconsistent ($n=6$). However there was evidence that postpartum PTSD is associated with low birth weight ($n=3$).

A large cross-sectional study compared Medicaid records of women who had been diagnosed with antenatal PTSD with a randomly selected comparison group of women with no mental health diagnostic codes (Seng, et al., 2001). They found that maternal PTSD was significantly associated with diagnostic codes for poor fetal growth and excessive fetal

growth. Antenatal PTSD was significantly associated with five obstetric complications, which included excessive fetal growth among ectopic pregnancy, miscarriage, hyperemesis, and preterm contractions. In a later study, (Seng, et al., 2011) also found that higher maternal PTSD symptom count during pregnancy was significantly correlated with low birth weight (LBW), although this correlation was small. In subsamples that did not experience childhood abuse, race and poverty accounted for more risk, and weakened this association. However, among childhood abuse survivors, this association was stronger, and this factor alone explained 7.9% of variance in their model.

However, four other studies found no association between antenatal PTSD and fetal growth. An epidemiological study of women exposed to the 9/11 attacks reported that probable antenatal PTSD was not associated with birth weight (Engel, et al., 2005). Similar results were found by (Rogal, et al., 2007) and (Morland, et al., 2007), who studied antenatal women in other areas of the USA. In another study of victims from Hurricane Katrina, (Xiong, et al., 2008) reported that LBW was three times more likely in women with antenatal PTSD, although this finding was statistically not significant.

In contrast, there was consistent evidence that postpartum PTSD is associated with LBW (n=3). (Lipkind, et al., 2010) reported that LBW was two-times more likely in women with higher PTSD scores. Similarly, Feeley et al.'s (2011) study of mothers of preterm infants found that those who reported more PTSD symptoms had infants who weighed less at birth. Furthermore, Ferri et al.'s (2007) study of disadvantaged Brazilian adolescents found that maternal PTSD was significantly correlated with LBW after adjusting for confounders and mediators.

3.2.2. Gestational duration and preterm birth

Evidence for a relationship between antenatal PTSD and gestational duration or preterm birth was inconsistent ($n=5$). One study examined the association between postpartum PTSD and gestational duration.

Yonkers et al.'s (2014) longitudinal study of 2487 women found that women with a likely diagnosis of antenatal PTSD had an elevated risk of preterm birth, which increased significantly when PTSD was co-morbid with depression. Additionally, in another longitudinal study of 1100 women, Rogal, et al. (2007) reported that preterm delivery was nearly three times more likely in mothers with antenatal PTSD, although this finding was not statistically significant. In contrast, three other studies found no association between antenatal PTSD and preterm birth. Xiong, et al. (2008) reported that antenatal PTSD was associated with a statistically non-significant decreased risk of preterm birth, and Seng, et al. (2011) reported that antenatal PTSD symptoms were not significantly associated with preterm birth. Engel, et al. (2005) also reported that probable antenatal PTSD was not associated with gestational duration.

Results in relation to postpartum PTSD are based on one study. Lipkind, et al. (2010) found that women with high PTSD scores were two times more likely to have had a preterm delivery, although probable postpartum PTSD was not associated with a difference in gestational age.

3.2.3. Head circumference

No association between antenatal PTSD and head circumference was found ($n = 1$). Engel, et al. (2005) reported that probable antenatal PTSD was not associated with infant head circumference at birth. No studies reported on the association between postpartum PTSD and head circumference.

3.2.4. Breastfeeding

Evidence for a negative association between postpartum PTSD and breastfeeding was consistent ($n=2$). No studies reported on the association between antenatal PTSD and breastfeeding. A study of Israeli women reported that significantly more women with postpartum PTSD symptoms did not breastfeed their infant 6-8 weeks postpartum (Halperin, et al., 2015). Furthermore, a large prospective US study found that women with higher postpartum PTSD scores were significantly less likely to have breastfed their infant for as long as they wanted to, and were significantly less likely to be exclusively breastfeeding at 1-month postpartum (Beck, et al., 2011).

3.3. Child development

Four papers reported on the association between maternal perinatal PTSD and child development outcomes. These outcomes included cognitive development, sleeping and eating difficulties, and infant cortisol levels (Table 2).

3.3.1. Cognitive development

There is inconsistent evidence for the association between postpartum PTSD and cognitive outcomes ($n=2$). No studies reported on the association between antenatal PTSD and cognitive development. A longitudinal study of UK couples found that maternal postpartum PTSD was moderately associated with poorer cognitive outcomes at 17-months postpartum (Parfitt, et al., 2014). Furthermore, maternal postpartum PTSD provided a unique significant contribution to the model in their regression analysis, which explained 27.5% of the variance of the cognitive score. However, another study of preterm infants reported that maternal postpartum PTSD symptom score was not related to infant cognitive development at six months postpartum (Feeley, et al., 2011).

3.3.2. Sleeping and eating difficulties

There is some evidence for the association between postpartum PTSD and sleeping and eating difficulties when combined ($n=1$). Pierrehumbert, et al. (2003) reported that there were no significant differences between preterm infants of mothers with high or low postpartum PTSD symptom scores in relation to sleeping or eating difficulties, compared to full-term infants. However, there was a significant difference between the aggregated index of these problems, in that mothers with a higher number of PTSD symptoms had significantly more difficulties with their preterm infant, with sleeping being most affected.

3.3.3. Salivary Cortisol

Some support exists for a negative association between perinatal PTSD and infant salivary cortisol levels ($n=1$). Analyzing the same sample used by Engel, et al. (2005), Yehuda, et al. (2005) reported that the infants of women with PTSD symptomatology had lower salivary cortisol levels. Furthermore, lower cortisol levels were most apparent in babies born to mothers with PTSD who experienced a traumatic event during their third trimester, although PTSD symptom severity in the entire sample was correlated with infant cortisol levels regardless of trimester.

3.4. Mother-infant relationship

Eleven papers reported on the association between maternal perinatal PTSD and the mother-infant relationship, including maternal interactional behavior, infant interactional behavior, and the parent-baby bond (Table 3).

3.4.1. Maternal interactional behavior

Evidence regarding the association between postpartum PTSD and maternal interactional behavior is inconsistent ($n=4$). No studies examined the association between antenatal PTSD and maternal interactional behavior. Muller-Nix, et al. (2004) and Forcada-Guex, et al. (2011) reported from the same longitudinal study of mothers of preterm infants. At six-months postpartum, higher postpartum PTSD symptom scores in mothers were associated with significantly lower maternal sensitivity and higher maternal control compared to full-term mothers (Muller-Nix, et al., 2004). The percentage of sensitive mother-cooperative-infant dyads was also significantly lower (Forcada-Guex, et al., 2011). Similar results were reported by Feeley, et al. (2011), who found that mothers of preterm infants with higher postpartum PTSD symptoms were less sensitive and effective at structuring interactions with their infant at six-months postpartum. Furthermore, using the Still Face Paradigm, Ionio and Di Blasio (2014) reported that postpartum PTSD symptoms were associated with mothers not looking directly at their infant, repeatedly touching their infant, and describing their infant's status in a negative way at three-months postpartum.

In contrast to these findings, two other studies found no association between postpartum PTSD and maternal interactional behavior. Parfitt et al.'s (2013) prospective longitudinal study reported that maternal postpartum PTSD was not significantly correlated with maternal sensitivity, control, or unresponsiveness at three-months postpartum, and Muller-Nix, et al. (2004) found maternal postpartum PTSD was not associated with maternal sensitivity, control, or unresponsiveness at 18-months postpartum.

3.4.2. Infant interactional behavior

Evidence for the association between postpartum PTSD and infant interactional behavior is inconsistent ($n=3$). No studies examined the association between antenatal PTSD and infant interactional behavior. At 18-months postpartum, higher PTSD scores in mothers

of preterm infants were associated with significantly greater infant compliance and passivity (Muller-Nix, et al., 2004). In relation to emotional reactivity at two months postpartum, infants of mothers with higher postpartum PTSD symptoms also showed significantly more disorganized behavior, such as distress and uncontrollable and inconsolable crying in the play episode of the Still Face Paradigm (Ionio & Di Blasio, 2014). In relation to emotion regulation, infants were less interested in objects nearby and showed more avoidance behaviors; in the still episode, infants more frequently looked away from their mother, and adopted behaviors aimed at creating a physical distance (Ionio & Di Blasio, 2014). Using a similar methodology, Bosquet Enlow, et al. (2011) also found that postpartum PTSD was associated with poorer infant recovery from distress, where infants of mothers with PTSD symptoms showed greater amounts of hard crying during the second reunion. Additionally, maternal PTSD symptoms were significantly correlated with maternal report of the infant's ability to recover once distressed at six-months postpartum, and were associated with infant symptoms of externalizing, internalizing, and dysregulation at 13-months postpartum (Bosquet Enlow, et al., 2011).

In contrast to these findings, other outcomes related to infant interactional behavior were not associated with postpartum PTSD. Bosquet Enlow, et al. (2011) reported minimal association between postpartum PTSD and infant emotional reactivity at six-months postpartum, and found that postpartum PTSD was not correlated with maternal report of infant distress in response to limits. Similarly, Muller-Nix, et al. (2004) found no significant association between mothers of preterm infants with higher PTSD symptom scores and infant cooperation, compliance, difficulty, or passivity at six-months postpartum.

3.4.3. Mother-infant bond

Findings on the association between postpartum PTSD and the mother-infant bond are inconsistent (n=7). No studies examined the association between antenatal PTSD and the mother-infant bond. Two survey studies described significant associations between PTSD symptoms and the mother-infant relationship. Davies, et al. (2008) reported that mothers with full or partial PTSD at six-weeks postpartum viewed their infants as being significantly less warm towards them, more invasive, and more difficult in temperament. Mothers with full PTSD also perceived attachment to their infants to be less optimal, which was characterized by greater infant-directed hostility, less desire for proximity, and less pleasure interacting with them. Similarly, Parfitt and Ayers (2009) reported that parents with postpartum PTSD reported a poorer relationship with their infant, and that parental PTSD was significantly correlated with the parent-baby bond. Seng, et al. (2013) also reported that pre-existing PTSD was an elevated risk factor for impaired bonding, although this finding was not statistically significant. Forcada-Guex, et al. (2011) found that mothers of preterm infants with high PTSD symptoms showed significantly less balanced and more distorted representations of their infants.

In contrast to these findings, three other studies found no association between postpartum PTSD and the parent-baby bond. Ayers, Wright, and Wells (2007) reported that postpartum PTSD symptoms were not associated with the parent baby bond; and McDonald, et al. (2011) failed to find an association between maternal PTSD symptoms six-weeks or three-months postpartum on maternal perception of the infant at two-years postpartum. Similarly, Parfitt, et al. (2014) reported that maternal PTSD at three-months postpartum was not significantly correlated with a poorer baby bond at three-months or 15-months postpartum.

4. Discussion

This systematic review synthesized and evaluated quantitative research on the association between maternal perinatal PTSD and postpartum birth outcomes, child development, and the mother-infant relationship. Findings suggest that maternal postpartum PTSD is associated with low birth weight and lower rates of breastfeeding. Evidence for an association between maternal PTSD and preterm birth, fetal growth, head circumference, mother-infant interaction, the mother-infant relationship or child development was contradictory. Associations between maternal PTSD and infants' salivary cortisol levels, and eating/sleeping difficulties were based on single studies, so require replication before conclusions can be drawn.

It is possible that the inconclusive outcomes in relation to perinatal PTSD and child outcomes are due to the methodological limitations of the research, including inconsistency in relation to sample size, study design, and measures of PTSD and child outcomes. Sample sizes across studies varied greatly, ranging from 21 (Feeley, et al., 2011) to 2487 (Yonkers, et al., 2014). Few studies ($n=4$) commented on whether they had sufficient power to detect a clinically-important effect: Rogal, et al. (2007) and Morland, et al. (2007) did not have sufficient power, whereas studies by Parfitt and Ayers (2009) and McDonald, et al. (2011) were well powered. However, the rest of the studies ($n=17$) did not report their sample size calculation, meaning that one cannot determine whether they were large enough to provide reliable outcomes.

The majority of studies ($n=17$) used prospective or longitudinal designs, which allowed measurement of individual change across an extended period of time. Although methodologically robust, prospective designs can be difficult to implement, as many women may not experience perinatal PTSD symptoms, and substantially larger sample sizes are therefore required. Prospective studies enable some consideration of the direction of causality over time. However, in terms of understanding the nature of the relationship between

maternal PTSD and child outcomes, these studies provide less evidence of causal links than randomized experiments. As a result, it is often not possible to ascertain whether maternal PTSD impacts upon child outcomes, or vice versa.

One study provided a large proportion of the participants included in this review (Seng, et al., 2001) but its cross-sectional design does not allow causal inference between maternal PTSD and child outcomes. Three studies (Ayers, et al., 2007; Davies, et al., 2008; Parfitt & Ayers, 2009) used a survey design, which may impact upon the external validity of their findings. Response rates to these studies were either poor or not discussed. It may be that mothers with particular beliefs were more likely to complete these surveys (e.g., women who already believed they had a difficult relationship with their infant may have been more inclined to participate in research investigating this relationship), which therefore limits the generalizability of the findings to real-world populations.

The absence of control or comparison groups in the majority of studies reviewed ($n=19$) meant that it is not possible to determine whether the child outcome findings are a result of responding to maternal PTSD symptomatology, or whether they would have occurred anyway over time due to other life circumstances. However, there were two exceptions: one epidemiological study (Engel, et al., 2005) used a control group, although these were taken from the same sample of participants. Another study (Muller-Nix, et al., 2004) used mothers of full-term infants from the same hospital as a comparison group for mothers of preterm infants.

Measurement of maternal PTSD relied entirely on self-report, which likely reduced the risk of researcher bias, although it may have inadvertently increased the risk of responder bias. Different measures of PTSD ($n=14$) were utilized across 21 studies. In general, these measures were reliable and valid. The most common measure was the Posttraumatic Stress Disorder Checklist (PCL) or Posttraumatic Stress Disorder Checklist–Civilian Version (PCL-

C) ($n=6$), a standardized questionnaire with robust psychometric properties. Several studies used childbirth or perinatal-specific PTSD measures: three studies (Feeley, et al., 2011; Ionio & Di Blasio, 2014; Pierrehumbert, et al., 2003) used the Perinatal Post-Traumatic Stress Disorder Questionnaire (PPQ) which is specifically designed to measure perinatal PTSD, and has been shown to have good convergent and discriminant validity within this population (Quinnell & Hynan, 1999). Furthermore, two studies (Beck, et al., 2011; Halperin, et al., 2015) used a childbirth-specific version of the Posttraumatic Stress Symptom Scale–Self-Report Version (PSS-SR), which again has been shown to provide reliable and valid information of PTSD diagnosis and severity.

The majority of studies ($n=19$) administered their PTSD measure in the perinatal period. However, in two studies, the timing of this measure did not guarantee that PTSD would have been experienced in the perinatal period (Lipkind, et al., 2010; Pierrehumbert, et al., 2003). For example, Pierrehumbert, et al. (2003) asked mothers at 18-months postpartum to retrospectively respond to the measure in relation to PTSD symptoms that had appeared since birth, and which had lasted more than one month. Not only does this mean that findings drawn from this study may extend beyond the perinatal period, but it is also possible that results may be biased by mothers' functional status and experiences of parenthood at time of answering the measure, and therefore be less reliable.

Numerous measures ($n=13$) were utilized across 21 studies to assess child outcomes. However, several studies observed mother-infant interactions, of which three studies used the CARE index to code mother-infant free play (Forcada-Guex, et al., 2011; Muller-Nix, et al., 2004; Parfitt, et al., 2013). This procedure has been validated for use with families across different social classes and cultural backgrounds, and has shown good-to-excellent inter-rater reliability (Leventhal, Jacobsen, Miller, & Quintana, 2004). Maternal self-report questionnaires were also used to measure the mother-infant interaction. Three studies used

the Peritraumatic Behavior Questionnaire (PBQ), a well-established measure with good reliability and validity. However, some studies utilized less robust outcome measures, such as a self-report version of the Bethlehem Mother-Infant Interaction Scale, which had not been tested against other measures of parent-baby bond (Ayers, et al., 2007). This lack of concurrent validity therefore makes it difficult to know how accurate or sensitive this measure of parent-baby bond was, and may explain why a non-significant association was found in this study (Ayers, et al., 2007).

The inconsistency of findings across the majority of child outcomes may reflect methodological differences between studies. For example, looking at maternal interactional behavior, all studies except for one (Parfitt, et al., 2013) used the Postpartum Bonding Questionnaire to assess maternal PTSD symptomatology, and a clinician-coded measure to assess maternal interactional behavior. It is possible that the use of a self-report measure to assess maternal interactional behavior may have biased the results, and be subject to social desirability bias, in that women with PTSD may have been more sensitive and felt more judged in relation to their ability to parent their infant, and may have answered the questions more positively compared to how they would have been observed interacting with their infant. This may also be relevant to the non-significant outcomes reported by Bosquet Enlow, et al. (2011) on infant interactional behavior, which used a similar design. Furthermore, it is likely that Parfitt, et al. (2013) did not find significant associations because their study was underpowered to report significant trends. Further studies using an observational design to assess maternal interactional behavior are therefore needed to clarify the relationship between maternal PTSD and maternal interactional behavior.

In relation to the mother-infant relationship, three used a sample of mothers and babies born preterm to investigate maternal interactional behavior. The findings suggested that high maternal PTSD symptoms were associated with lower sensitivity when interacting

with their infant at six-months postpartum. However, two of these papers reported results from the same sample of participants. Additionally, these studies used different measures to assess this relationship, which significantly limits the comparability across studies. Despite this, differences were also found in more representative samples, in that maternal PTSD symptoms were associated with negative maternal interactional behaviors two-months postpartum (Ionio & Di Blasio, 2014). It is likely that Parfitt, et al. (2013) did not find significant associations because their study was underpowered to report significant trends. Therefore, it is possible that postpartum PTSD may have an impact on maternal interactional behavior.

Findings regarding infant interactional behavior were mixed. One study found no association between postpartum PTSD and infant behavior at six-months (Muller-Nix, et al., 2004), and another found no association with maternal reports of the infant's tendency to become distressed in response to limits (Bosquet Enlow, et al., 2011). However, it may be that self-report measures are subject to social desirability bias, in that women with PTSD may have been more sensitive and felt more judged in relation to their ability to parent their infant, and may have answered the questions more positively compared to how they would have been observed interacting with their infant. Conversely, infants of mothers with higher postpartum PTSD displayed more disorganized and avoidance behaviors at two-months postpartum (Ionio & Di Blasio, 2014). Additionally, maternal PTSD symptoms were significantly correlated with the infant's ability to recover once distressed at six-months postpartum (Bosquet Enlow, et al., 2011), although these two studies used different versions of the Still Face Paradigm (SFP), meaning that these findings are again not easily comparable across samples. Important limitations of these studies are their small sample size and an increased probability of Type I errors due to the high number of statistical tests used on the data.

In relation to the mother-infant bond, evidence is mixed. Two small survey studies reported a significant negative association with postpartum PTSD. One study that included mothers with partial and full PTSD symptomatology found medium-to-large significant effects of this relationship, in that infants were viewed as less warm, more invasive, and more difficult in temperament (Davies, et al., 2008). Interestingly, the largest effect size was demonstrated by mothers with full PTSD symptomatology who perceived their attachment to their infants as problematic. This finding was supported by Parfitt and Ayers (2009), who also reported that parental postpartum PTSD was significantly correlated with parent-baby bond, although this is limited by their results not distinguishing between maternal and paternal PTSD. Prospective studies also found that postpartum PTSD was associated with the mother-infant bond, including Seng, et al. (2013) who found that mothers with pre-existing PTSD had an elevated risk of impaired bonding. Therefore, despite other less robust studies finding no association between postpartum PTSD and the mother-infant bond, it seems reasonable to conclude there is stronger evidence in support of this association.

Overall, the evidence points to an association between maternal perinatal PTSD and the mother-infant relationship. It seems likely that PTSD is associated with maternal interpretations of her infant's behaviors during a critical period of bonding. It seems logical that this may also impact upon infant behavior, in that infants may attempt to modify their mother's interactional style through avoidance or 'active protest' displays of behavior. However, it should also be noted that comparison across these studies is limited, given the vast range of (often not well validated) measures used to assess the relationship.

None of the studies reporting postpartum birth outcomes ($n=11$) used validated measures to extract their data. Alternatively, birth outcome information was extracted from medical records for the majority of these studies ($n=10$), and the variables assessed are not the same across studies. Additionally, one study found that clinicians were unwilling to

provide this information, which rendered the data inadequate for analysis, and introduced another level of bias (Yonkers, et al., 2014). However, two studies (Halperin, et al., 2015; Yonkers, et al., 2014) created self-report questionnaires to gather this data retrospectively from mothers. This also poses risks of recall bias, although one study collected this information within 28 hours after birth, in an attempt to reduce this risk (Halperin, et al., 2015).

Regarding postnatal birth outcomes, results showed mixed findings in relation to an association with fetal growth. The majority of studies, some of which included the largest studies included in this review, pointed to a non-significant relationship between low birth weight and antenatal maternal PTSD. Despite this, mothers from developed and underdeveloped countries with postpartum PTSD were reported as up to three-times more likely of having delivered a low birth weight child (Ferri, et al., 2007; Lipkind, et al., 2010; Xiong, et al., 2008). However, one study may have sampled women who experienced PTSD beyond the perinatal period (Lipkind, et al., 2010), meaning that the generalizability of these findings may be limited. Nevertheless, this remains a notable finding, and is of interest to explore further.

Mixed findings were reported regarding an association with preterm birth. Two relatively large studies suggested that antenatal PTSD was not significantly associated with preterm delivery (Rogal, et al., 2007; Seng, et al., 2011), although it was almost three-times more likely to occur in mothers with antenatal PTSD (Rogal, et al., 2007). Adding to this, one of the most robust studies included in this review reported that risk of preterm birth was elevated in women with a likely diagnosis of antenatal PTSD, and this increased when antenatal PTSD was comorbid with depression (Yonkers, et al., 2014). However, women with a likely diagnosis of antenatal PTSD in this sample varied noticeably to those with threshold level symptoms, e.g., regarding socioeconomic status and use of substances.

Although these were included as potential confounders in their analysis, it suggests that other residual confounding factors may not have been accounted for, and therefore may have contributed to these findings. Furthermore, results may imply that a PTSD diagnosis is associated with preterm birth but less severe PTSD symptoms are not.

Two studies found a negative relationship between postpartum PTSD and breastfeeding, and seemed to support the notion that these women are significantly less likely to breastfeed their infants during the early perinatal period, or for as long as they wanted to. Drawing upon research investigating other maternal mental health difficulties, studies have consistently demonstrated a link between breastfeeding and both antenatal and postnatal depression. A recent systemic review demonstrated that early exclusive and non-exclusive breastfeeding is associated with the presence of postpartum depression (Dias & Figueiredo, 2015). The review also suggested that postpartum depressive symptoms were shown to predict early breastfeeding cessation, and that both antenatal and postpartum depression were associated with shorter breastfeeding duration (Dias & Figueiredo, 2015). Interestingly, Dias and Figueiredo (2015) reported that prospective research in the field points to the role of depressive symptoms during pregnancy on breastfeeding duration, and the role of breastfeeding duration on the maintenance of depressive symptoms throughout the postpartum period.

Given that depression and PTSD are both subject to negative alterations in mood and cognitions (American Psychiatric Association, 2013) and are often co-morbid (Campbell, et al., 2007), it may be that mechanisms underlying the association between breastfeeding and maternal PTSD are similar to those described above, and may provide some initial support on the direction of the association between breastfeeding and perinatal PTSD. Within this, it may also be that mechanisms underlying breastfeeding duration differ from those underlying breastfeeding initiation, which further highlights the need for prospective research to

investigate this association in the context of perinatal PTSD. Given that breastfeeding offers a wide range of benefits to both the child and mother (Brion, et al., 2011; Duijts, Jaddoe, Hofman, & Moll, 2010), interventions aimed at women experiencing antenatal and postpartum PTSD may be helpful to enhance both the wellbeing and psychological adjustment of mother and infant.

Studies investigating the relationship between perinatal PTSD and child development were limited in number. Only two studies assessed cognitive development, and produced inconsistent findings. Feeley, et al. (2011) sampled mothers of preterm infants and found that postpartum PTSD symptoms were not related to infant cognitive development at six months. However, given the small sample size, it is possible that the study was underpowered, which may have resulted in a Type II error. A study using a potentially more representative sample of parents suggested that maternal postpartum PTSD was moderately associated with poorer cognitive development at 15 months but not with language or motor development (Parfitt, et al., 2014). However, a major limitation of this study was also its sample size, which limited its statistical power and the types of analyses possible. Results from single studies investigating the association between maternal PTSD and salivary cortisol levels in infants (Yehuda, et al., 2005), and sleeping and eating difficulties (Pierrehumbert, et al., 2003) are interesting, but again should be interpreted prudently given that there are no comparative studies, and that the number of mothers with perinatal PTSD included in these studies is unknown.

4.1. Strengths and limitations

The findings reported in this review are the result of a systematic methodological approach to gathering relevant research evidence. However, the papers included represent great variability in measures of maternal perinatal PTSD and child outcomes, making it

difficult to make comparisons and draw conclusions. Although the review has considered the relationship between perinatal PTSD and child outcomes across a variety of settings and cultures, direct comparison between studies are challenging.

Furthermore, although women were categorized as experiencing either antenatal or postpartum PTSD in this review, it is possible that participants within these studies did not separate neatly into one of these two groups. Despite this, and given that the literature had been previously organized in this way, the authors thought that using these two categories was the most appropriate way of drawing together such disparate literature relating to child outcomes.

Validated measures were not used to collect postpartum birth outcome information in any of the eleven studies examining birth outcomes included in this review, which may limit the reliability and validity of these findings. Future research would benefit from using a standardized measure of postnatal birth outcomes, which could be compared reliably across studies of perinatal PTSD. Furthermore, including relevant unpublished work may have helped to reduce the effects of a publication bias.

4.2. Implications for clinical practice, policy, and research

The findings of the review suggest that perinatal PTSD may carry particular risks for some infant outcomes, including during pregnancy. Therefore, proactive early screening for PTSD during the perinatal period would be justifiable to facilitate the detection and onward referral for effective treatment. The perinatal period provides the perfect time for professionals across disciplines (e.g., midwives, health visitors, GPs, clinical psychologists) to work together, as such frequent contact with women provides opportunities for prevention.

In reviewing the evidence base, the World Health Organization (WHO, 2009) recommended perinatal interventions to promote maternal mental health in both resource-

constrained settings and developed countries, highlighting the need for interventions to be simple and practical in order to address both individual needs and family functioning. Assessing women during routine antenatal and postpartum appointments, using structured questionnaires or appropriately validated and culturally-sensitive self-report questionnaires may be beneficial, as well as developing stepped intervention protocols, establishing clearly defined pathways, and fostering health service development (Fisher et al., 2011). In parallel, the WHO also simultaneously recommended interventions to promote child health and development, specifically attending to the child's needs whilst strengthening the mother-infant relationship. This includes providing psycho-educational interventions within antenatal and postpartum health care services, which combine information provision with psychological support, as well as interventions that aim to improve maternal responsiveness and the mother-child relationship (Fisher et al., 2011).

In relation to the treatment of PTSD, the American Psychiatric Association (Ursano et al., 2004) and Department of Veteran Affairs (2010) recommend trauma-focused psychotherapy, which includes components of exposure and/or cognitive restructuring, or stress inoculation training as preferred psychological interventions, alongside psycho-education for patients and families. With a specific focus on the perinatal period, the National Institute for Clinical Excellence guidelines (NICE, 2015) on antenatal and postnatal mental health recommend that mothers who have PTSD resulting from traumatic childbirth, miscarriage, stillbirth, or neonatal death, are offered a high-intensity psychological intervention, in line with NICE guidelines on PTSD (NICE, 2005).

However, despite the guidance and policy drivers advocating for perinatal mental health services, provision of these services is patchy (Bauer et al., 2014). Therefore, more needs to be done to not only to develop consistent organizational service structures to facilitate integrated care pathways, but also to standardize the mental health training and

educational opportunities across professionals from different disciplines, such as health visitors and midwives, who are in a central position to prevent the adverse consequences of maternal perinatal PTSD.

Research investigating the association between maternal perinatal PTSD and child outcomes is in its infancy. Future research using larger sample sizes, validated and reliable clinical interviews to assess PTSD, and validated measures to assess a range of child outcomes, would be of benefit. Furthermore, investigation over longer periods of time would benefit our understanding of the long-term impact of this relationship. Lastly, adopting more robust experimental design methodologies would permit the inference of causality, and enhance our understanding of this relationship.

5. Conclusions

The evidence reviewed here supports an association between maternal postpartum PTSD with low birth weight and lower rates of breastfeeding. Evidence for an association between maternal PTSD and preterm birth, fetal growth, head circumference, mother-infant interaction, mother-infant relationship or child development was contradictory. Associations between maternal PTSD and infant salivary cortisol levels, and eating/sleeping difficulties were based on single studies, so require replication before conclusions can be drawn. Although this review deepens our understanding of the association between perinatal PTSD and child outcomes, methodological variability and limitations make it difficult to draw firm conclusions. Future research using validated measures, larger samples, and a prospective design to expand our understanding of this pivotal relationship are needed.

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Table 1.

Summary of studies on post-natal birth outcomes (n = 11)

Study (Design)	Sample					Maternal PTSD assessment	Child outcome assessment/outcome	Findings
	N*	Age (Mean)	Country	N with PTSD symptomatology	Sampling method			
Seng et al. (2001) (Cross-sectional study)	1093	23.3 years (PTSD) 24.0 years (comparison)	USA	455 (42%)	Used Michigan's Medicaid Eligibility and Paid claims records to identify suitable participants. Compared to randomly selected comparison group with no mental health diagnostic codes. Data from 3 years. Convenience sample.	(Antenatal PTSD) ICD-9 code taken from clinical records	Rates of hospital coding for obstetric complications	Diagnostic codes for poor fetal growth and excessive fetal growth were significantly associated with maternal PTSD Logistical regression model found five obstetric complications to be significantly associated with maternal PTSD, one of which was excessive fetal growth
Engel et al. (2005) (Prospective epidemiological study)	54	Not reported	USA	4 (7%)	Recruited women who were within one of five zones of exposure during 9/11, or within succeeding three weeks (media ads, letters to obstetricians, fliers). Enrolment across 11 months. Convenience sampling.	(Antenatal PTSD) PCL	Birth outcome information from medical records	Probable PTSD was not associated with gestational duration, birthweight, or head circumference.
Rogal et al. (2007) (Longitudinal cohort study)	1100	24.3 years (PTSD) 24.5 (No PTSD)	USA	31 (3%)	Recruited from prenatal clinics in inner city New Haven, Connecticut. Convenience sampling.	(Antenatal PTSD) MINI International Neuropsychiatric Interview 5.0	Obstetric data from medical records	Preterm delivery, gestational age, and low birth weight were not significantly associated with antenatal PTSD. Preterm delivery was nearly three-times more likely in mothers with antenatal PTSD

Morland et al. (2007)	101	27 years	USA	Subclinical PTSD = 23 (23%) PTSD = 16 (16%)	Recruited from hospital-based obstetrics/gynaecology clinic and from private physicians' offices associated with community medical centre. Convenience sampling.	(Antenatal PTSD) PCL-C	Obstetric data from medical records	Antenatal PTSD was not significantly associated with low birth weight.
(Longitudinal cohort study)								
Ferri et al. (2007)	912	Mean unknown	Brazil	91 (10%)	Recruited from only public hospital in poor neighbourhood in the north of Sao Paulo. Consecutive pregnant adolescents admitted to hospital for obstetric care were invited to take part over 16 months. Convenience sample.	(Perinatal PTSD) CIDI 2.1 version	Newborn outcomes	PTSD was significantly associated with low birth weight
(Prospective study)		(Range = 11-19 years)						
Xiong et al. (2008)	277	Mean or range unknown	USA	13 (5%)	Recruited from prenatal clinics in Baton Rouge and New Orleans over 18 months. Convenience sampling.	(Antenatal PTSD) PCL-C	Newborn outcomes	Antenatal PTSD was associated with a statistically non-significant increased risk of low birth weight - low birth weight was three-times more likely in for women with antenatal PTSD. Antenatal PTSD was associated with a statistically non-significant decreased risk of preterm birth.
(Prospective cohort study)		(Range = 18 – ≥35)						
Lipkind et al. (2010)	446	Mean unknown	USA	61 (12%)	Used data from World Trade Center Health Registry (recruited women who had been pregnant between 9/11 and 12/1 - self-identified and list identified). 15 month enrolment period. Convenience sampling	(Postpartum PTSD) PCL	Birth characteristic taken from Department of Health and Mental Hygiene's Office of Vital Statistics.	Probable PTSD was not associated with a difference in gestational age of delivery. Preterm delivery was two-times more likely in women with high PTSD scores. Probable PTSD was significantly associated with a difference in birth weight (unadjusted), but this was not significant when controlling for confounding variables.
(Prospective epidemiological study)		(Range = 18 – ≥35)						

								Low birth weight was two-times more likely in women with high PTSD scores.
Seng et al. (2011) (Prospective three-cohort study)	839	Unknown	USA	98 (12%)	Recruited from prenatal clinics of three large health systems in Michigan over 19 months. Over-sampled from low SES clinics Convenience sampling.	(Antenatal PTSD) National Women's Study PTSD Module	Newborn outcomes taken from hospital records	Current PTSD symptom count was not significantly associated with pre-term birth. Current PTSD symptom count was significantly associated with lower birth weight, compared to trauma-exposed resilient cohort and non-exposed cohort.
Beck et al. (2011) (Prospective study)	903	Unknown	USA	DSM-IV diagnostic criteria = 81 (9%) Above cut-off for PSS-SR = 163 (18%)	Follow-up from LTM II survey – asked to complete questionnaire 6 months later (LTM II/PP) over two months. Convenience sampling.	(Postpartum PTSD) DSM-IV PTSD diagnosis PSS-SR	Created questionnaire to abstract 23 new-onset physical problem after childbirth within first two months postpartum	Women with higher PTSD scores were significantly less likely to have breastfed their infant for as long as they wanted to, and were significantly less likely to be exclusively breast-feeding at 1 month postpartum.
Halperin et al. (2014) (Prospective study)	171	28.95 years	Israel	16 (9%)	Recruited from two postpartum units of two major public hospitals in Israel over 12 months. Convenience sampling.	(Postpartum PTSD) PSS-SR	Child birth variables collected from self-report questionnaire 24-28 hours after childbirth	Significantly more women with PTSD symptoms did not breastfeed their infant.
Yonkers et al. (2014) (Longitudinal prospective cohort study)	2487	Mean Unknown (Range = ≤ 25 to ≥ 35 years)	USA	129 (4.9%)	Recruited from 137 obstetrical practices in Connecticut and Western Massachusetts over 50 months. Convenience sampling	(Antenatal PTSD) MPSS	Taken from self-report questionnaire and data from medical records	Risk of preterm birth was elevated in women with a likely diagnosis of PTSD (Adjusted OR = 1.22, 95% C.I. 0.57-2.61)

Note: N* = Number of participants who completed the study; PCL = Post-traumatic Stress Disorder Checklist; PCL-C = Posttraumatic Stress Disorder Checklist – Civilian Version; CIDI = Composite International Diagnostic Interview; LTM II = Listening To Mothers; LTM II/PP = Listening To Mothers II Postpartum Survey; PSS-SR = Posttraumatic Stress Disorder Symptom Scale-Self Report; MPSS = Modified PTSD Symptom Scale

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Table 2

Summary of studies on child development ($n = 4$)

Study (Design)	Sample					Maternal PTSD assessment	Child outcome assessment/outcome	Findings
	N*	Age (Mean)	Country	N with PTSD symptomatology	Sampling method			
Pierrehumbert et al. (2003) (Longitudinal prospective study)	75 families	Parent of high risk infant = 31 years Parent of low risk infant = 30 years Control = 32 years	Switzerland	Unknown	All preterm infants admitted to NICU in University Hospital in Lausanne were considered. Recruited over 12 months. Controls recruited from maternity unit of same hospital. Convenience sample	(Postpartum PTSD) PPQ	SCL	There was no significant difference between preterm infants of mothers with high or low PPQ, and controls, in relation to sleeping or eating difficulties. However, there was a statistically significant difference between the aggregated index of problems (sleeping and eating), with significantly more difficulties with premature infants of mothers with high PPQ, although sleeping problems appear to be most affected.
Yehuda et al. (2005) (Prospective, longitudinal, epidemiological study)	38 dyads	Unknown	USA	Unknown	Recruited women who were within one of five zones of exposure during 9/11, or within succeeding three weeks (media ads, letters to obstetricians, fliers). Convenience sampling.	(Perinatal PTSD) PCL	Infant cortisol levels at awakening and bedtime	Infant salivary cortisol was lower in infants of women with PTSD. Lower cortisol levels were most apparent in babies born to mothers with PTSD in their third trimesters on 9/11.
Feeley et al. (2011) (Prospective study)	21 dyads	31 years	Canada	5 (24%)	Recruited from NICU in University Hospital in Montreal. Convenience sample	(Postpartum PTSD) PPQ	Mental Development Index (taken from Bayley-III) Emotional Availability Scales	Maternal PTSD symptom score was not related to infant cognitive development at 6-months postpartum. *Mothers who reported more PTSD symptoms had infants who weighed less at birth

								** Mothers who reported more PTSD symptoms were less sensitive and less effective at structuring interactions with their infant.
Parfitt et al. (2014a)	42 families	Unknown	UK	Unknown	Recruited from the Sussex Journey to Parenthood study. Convenience sample	(Postpartum PTSD) Birmingham Interview of Maternal Mental Health	Bayley-III	Maternal postpartum PTSD was moderately associated with poorer cognitive outcomes, but was not significantly associated with language or motor scores. In regression analysis, maternal postpartum PTSD provided a unique significant contribution to the model, which explained 27.5% of the variance of the cognitive score.

Note: N* = Number of participants who completed the study; NICU = Neonatal Intensive Care Unit; PPQ = Perinatal PTSD Questionnaire; SCL = Symptom Checklist; PCL = Post-traumatic Stress Disorder Checklist; * = finding relevant to post-natal birth outcomes (Table 1); ** = finding relevant to mother-infant relationship/interaction (Table 3); Bayley-III= Bayley Scales of Infant and Toddler Development, Third Edition;

Table 3.

Summary of studies on mother-infant relationship (n = 11)

Study (Design)	Sample					Maternal PTSD assessment	Child outcome assessment/outcome	Findings
	N*	Age (Mean)	Country	N with PTSD symptomatology	Sampling method			
Muller-Nix et al. (2004) (Longitudinal prospective study)	72 families	High risk preterm dyad = 32 years Low risk preterm dyad = 31 years Full term dyad = 32 years	Switzerland	High risk dyad = 11(39%) Low risk dyad = 4 (21%) Full term dyad = 1 4%)	All preterm infants admitted to NICU in University Hospital in Lausanne were considered. Recruited over 12 months. Controls recruited from maternity unit of same hospital. Convenience sample.	(Postpartum PTSD) PPQ	Mother-child interaction coded using CARE Index procedure	<u>At 6 months:</u> (a) high-stress PPQ mothers of preterm infants were associated with significantly lower maternal sensitivity and significantly higher maternal control compared with full-term mothers; (b) there were no differences in maternal unresponsiveness between groups; (c) there were no significant difference in infant's cooperation, compliance, difficulty, or passivity between groups. <u>At 18 months:</u> (d) there were no significant differences in maternal sensitivity, control, or unresponsiveness between groups. (e) high-stress PPQ mothers of preterm infants were associated with significantly greater infant compliance and passivity.
Ayers et al. (2007) (Survey)	64 families	32 years	UK	3 (5%)	Recruited all eligible couples from maternity ward register of London hospital within one-month period. Convenience sample.	(Postpartum PTSD) IES	Bethlehem Mother-Infant Interaction Scale	Maternal PTSD symptoms were not associated with the mother-baby bond.

Davis et al. (2008) (Survey)	211	FT = 26 years PS = 30 years NS = 30 years	UK	FT = 8 (3.8%) PS = 45 (21.3%)	Recruited from postpartum inpatient unit at Sheffield maternity hospital. Convenience sample.	(Postpartum PTSD) PTSDQ	MORS-SF ICQ MPAS	Mothers with FT or PS PTSD symptoms viewed their infant as being significantly less warm towards them, more invasive and more difficult in temperament. Mothers with FT or PS PTSD symptoms perceived their attachment to be significantly less optimal, and perceived greater infant-directed hostility and less pleasure interacting with their infants. FT mothers also reported significantly less desire for proximity to their infant.
Parfitt & Ayers (2009) (Survey)	151	30 years	UK	8 (5%) Co-morbid PTSD and depression = 23 (15%)	Recruited from the internet and local organizations. Convenience sample.	(Postpartum PTSD) PDS	PBQ	PTSD was significantly correlated with the parent-baby bond. Parents with PTSD reported a significantly poorer relationship with their infant. Structural equation modelling suggested that the parent-baby bond was most strongly associated with postpartum PTSD symptoms.
Bosquet Enlow et al. (2011) (Longitudinal study)	52 dyads	27 years	USA	14 (27%)	Recruited from two major hospitals in Boston and three urban community health centers across 37 months. Convenience sample.	(Postpartum PTSD) PCL-C	IBQ-R ITSEA SFP-R	<u>Maternal perception:</u> Maternal PTSD symptoms were not significantly associated with measures of infant emotional reactivity. Maternal PTSD symptoms were significantly correlated with maternal reports of the infant's ability to recover once distressed. <u>SFP-R at 6 months:</u> Maternal PTSD showed minimal associations with infant emotional reactivity although infants of mothers with symptoms of PTSD to show a greater increase in hard crying during the second still-face episode relative to the first still-face episode.

								<p>Maternal PTSD was associated with infant recovery from distress; infants of mothers with symptoms of PTSD showed greater amounts of hard crying during the second reunion than during the baseline play episode, the first reunion, and the second still-face episodes.</p> <p>Infants of mothers without elevated symptoms of PTSD showed higher amounts of fussing in the second reunion relative to the first reunion but low levels of hard crying throughout the procedure.</p>
McDonald et al. (2011)	81	32 years	UK	14 (17%)	Recruited women who had taken part in a previous study. Convenience sample.	(Postpartum PTSD) PTSDQ IES	MORS-SF PSI-SF	Early PTSD symptoms (at either 6 weeks or 3 months postpartum) was not significantly correlated with maternal perception of the child at 2 years postpartum.
Forcada-Guex et al. (2011)	47 dyads	Not discussed	Switzerland	16 (34%)	All preterm infants admitted to NICU in University Hospital in Lausanne were considered. Recruited over 12 months. Controls recruited from maternity unit of same hospital.	(Postpartum PTSD) PPQ	WMCI Mother-child interaction coded using CARE Index procedure	<p>Mothers of preterm infants with high PTS-S were significantly more likely to be in “controlling” dyadic patterns of interaction, and show more “distorted” and less “balanced” representations of the infant.</p> <p>Percentage of ‘sensitive mother-cooperative infant’ dyads was significantly lower in the high PTS-S group</p>
Seng et al. (2013)	566	27 years	USA	34 (6%) (New onset postpartum PTSD = 9)	Recruited from prenatal clinics of three large health systems in Michigan across 33 months. Convenience sampling.	(Perinatal PTSD) National Women’s Study PTSD Module	PBQ	Pre-existing maternal PTSD was an elevated risk factor for impaired bonding.

Parfitt et al. (2013)	45 families	33 years	UK	Unknown	Recruited from the Sussex Journey to Parenthood study, mainly through hospital and community antenatal clinics and classes. Convenience sample	(Perinatal PTSD) PDS	Parent-child interaction coded using CARE Index procedure	Maternal PTSD was not significantly correlated with any maternal sensitivity, control, or unresponsiveness. Maternal PTSD was not significantly correlated with infant cooperation, difficulty, compliance or passivity.
Parfitt et al. (2014b)	75 dyads	33 years	UK	Unknown	Recruited from the Sussex Journey to Parenthood study. Convenience sample.	(Perinatal PTSD) PDS	ICQ PBQ	Maternal PTSD at three months postpartum was not significantly correlated with a poorer baby-bond at 3-months and 15-months postpartum.
Ionio & Di Blasio (2014)	58 dyads	32 years	Italy	2 days postpartum = 2 (10.5%) 2 months postpartum = 4 (21.2%)	Recruited from antenatal courses in Northern Italy. Convenience sample.	(Postpartum PTSD) PPQ	SFP coded using IRSS and MRSS	Infants whose mothers had higher PTSD symptoms at two months were less interested in objects nearby and showed more avoidance behaviors, e.g. in Still phase, infants more frequently looked away and adopted behaviors which physically distanced themselves from their mother. In Play phase, infants showed significantly more disorganized behavior, such as distress and uncontrollable and inconsolable crying. Maternal PTSD symptoms were associated with not looking directly at their infant, repeatedly touching their infant, and describing their child's status in a negative way.

Note: N* = Number of participants who completed the study; FT = fully symptomatic; PS = partially symptomatic; NS = nonsymptomatic; PPQ = Perinatal PTSD Questionnaire; IES = Impact of Events Scale; PTSDQ = Post-Traumatic Stress Disorder Questionnaire; MORS-SF = Mother's Object Relations Scale – Short Form; ICQ = Infant Characteristics Questionnaire; MPAS = Maternal Postnatal Attachment Scale; PDS = Posttraumatic Stress Diagnostic Scale; PBQ = Postpartum Bonding Questionnaire; PCL-C = Posttraumatic Stress Disorder Checklist – Civilian Version; IBQ-R = Infant Behavior Questionnaire-Revised; ITSEA = Infant-Toddler Social and Emotional Assessment; SFP-R = Repeated Still-Face Paradigm; PSI-SF = Parenting Stress Index – Short Form; WMCI = Working Model of the Child Interview; PTS-S = posttraumatic stress symptomology; SFP = Still-Face Paradigm; IRSS = Infant Regulatory Scoring System; MRSS = Maternal Regulatory Scoring System

Appendix A

Summary of Search Strategy

		Combined results from EMBASE, BNI, Medline, PsycInfo, and CINAHL
1	perinatal	145601 results
2	postnatal	215805 results
3	pregnan*	991195 results
4	childbirth	38934 results
5	1 OR 2 OR 3 OR 4	1272787 results
6	PTSD	65073 results
7	post AND traumatic AND stress AND disorder	27316 results
8	posttraumatic AND stress AND disorder	51006 results
9	6 OR 7 OR 8	86649 results
10	child AND outcome*	111501 results
11	child AND development	149952 results
12	child AND behavio*	122216 results
13	attachment	210456 results
14	mother AND infant	56781 results
15	low AND birth AND weight	70615 results
16	breast AND feeding	35773 results
17	10 OR 11 OR 12 OR 13 OR 14 OR 15 OR 16	659591 results
18	5 AND 9 AND 17	357 results